

## The Sloan Digital Sky Survey Data Release 7 M Dwarf Spectroscopic Catalog

Andrew A. West<sup>1</sup>, Dylan P. Morgan<sup>1</sup>, John J. Bochanski<sup>2,3</sup>, Jan Marie Andersen<sup>1</sup>, Keaton J. Bell<sup>4</sup>, Adam F. Kowalski<sup>4</sup>, James R. A. Davenport<sup>4</sup>, Suzanne L. Hawley<sup>4</sup>, Sarah J. Schmidt<sup>4</sup>, David Bernat<sup>5</sup>, Eric J. Hilton<sup>4</sup>, Philip Muirhead<sup>5</sup>, Kevin R. Covey<sup>1,5</sup>, Bárbara Rojas-Ayala<sup>5</sup>, Everett Schlawin<sup>5</sup>, Mary Gooding<sup>6</sup>, Kyle Schluns<sup>1</sup>, Saurav Dhital<sup>7</sup>, J. Sebastian Pineda<sup>3</sup>, David O. Jones<sup>1</sup>

<sup>1</sup>*Department of Astronomy, Boston University, 725 Commonwealth Avenue, Boston, MA 02215, USA, email: aawest@bu.edu, dpmorg@bu.edu, janmarie@bu.edu, kcovey@astro.cornell.edu, kschluns@bu.edu, jonesd@bu.edu*

<sup>2</sup>*Astronomy and Astrophysics Department, Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA, email: jjb29@psu.edu*

<sup>3</sup>*Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, Building 37, 77 Massachusetts Avenue, Cambridge, MA 02139, USA, email: jspineda@caltech.edu*

<sup>4</sup>*Astronomy Department, University of Washington, Box 351580, Seattle, WA 98195, USA, email: keatonbell@comcast.net, kowalski@astro.washington.edu, jrad@astro.washington.edu, slh@astro.washington.edu, sjschmidt@astro.washington.edu, hilton@astro.washington.edu*

<sup>5</sup>*Department of Astronomy, Cornell University, 610 Space Sciences Building, Ithaca, NY 14853, USA, email: david.bernat@gmail.com, muirhead@astro.cornell.edu, babs@astro.cornell.edu, everett.schlawin@gmail.com*

<sup>6</sup>*Wells College, Department of Mathematical and Physical Sciences, 170 Main Street, Aurora, NY 13026, USA, email: mgooding256@gmail.com*

<sup>7</sup>*Physics and Astronomy Department, Vanderbilt University, 6301 Stevenson Center, Nashville, TN 37235, USA, email: saurav.dhital@vanderbilt.edu*

**Abstract.** We present a spectroscopic catalog of 70,841 visually inspected M dwarfs from the seventh data release (DR7) of the Sloan Digital Sky Survey (SDSS). For each spectrum, we provide measurements of the spectral type, a number of molecular bandheads, and the H $\alpha$ , H $\beta$ , H $\gamma$ , H $\delta$  and Ca II K emission lines. In addition, we calculate the metallicity-sensitive parameter  $\zeta$  and 3D space motions for most of the stars in the sample. Our catalog is cross-matched to Two Micron All Sky Survey (2MASS) infrared data, and contains photometric distances for each star. Future studies will use these

data to thoroughly examine magnetic activity and kinematics in late-type M dwarfs and examine the chemical and dynamical history of the local Milky Way.

## 1. Description of the Catalog

We provide a brief description of some of the measured quantities in our Sloan Digital Sky Survey (SDSS; York et al. 2000) Data Release 7 (DR7; Abazajian et al. 2009) value-added catalog below. A much more thorough description of the catalog selection and its bulk characteristics can be found in West et al. (2010). The catalog will eventually be available on the Vizier<sup>1</sup> site, but can also be obtained immediately by contacting the primary author (AAW).

We visually inspected 116,161 M dwarf candidates (color selected from the SDSS database) and manually assigned spectral types. The sample was divided among 17 individuals<sup>2</sup> who used the manual “eyecheck” mode of the Hammer (v. 1.2.5; Covey et al. 2007) to assign spectral types and remove non-M dwarf interlopers, resulting in 70,841 M dwarfs (see Figure 1). We also matched our catalog to the 2MASS point source catalog (Cutri et al. 2003), matching only to unique 2MASS counterparts within 5'' of the SDSS position that do not fall within the boundaries of an extended source (GAL\_CONTAM=0).

Radial velocities (RVs) were measured by cross-correlating each spectrum with the appropriate Bochanski et al. (2007) M dwarf template. This method has been shown to produce uncertainties ranging from 7-10 km s<sup>-1</sup> (Bochanski et al. 2007). All of the DR7 objects were cross-matched to the USNO-B/SDSS proper motion catalog (Munn et al. 2004, 2008), identifying 39,151 M dwarfs with good proper motions. Distances to each star were calculated using the  $M_r$  vs.  $r-z$  color-magnitude relation given in Bochanski et al. (2010). The proper motions and distances were combined with the RVs to produce 3-dimensional space motions for the DR7 M dwarfs.

As part of our analysis, we measured a number of spectral lines and molecular features in each M dwarf spectrum. All of the spectral measurements were made using the RV corrected spectra. The TiO1, TiO2, TiO3, TiO4, TiO5, TiO8, CaOH, CaH1, CaH2, and CaH3 molecular bandhead indices and their formal uncertainties were measured using the Hammer with the molecular bandheads as defined by Reid et al. (1995) and Gizis (1997). We also measured the chromospheric hydrogen Balmer and Ca II lines that are associated with magnetic activity. We expanded the H $\alpha$  analysis of West et al. (2004, 2008) to include H $\beta$ , H $\gamma$ , H $\delta$  and Ca II K (H $\epsilon$  and Ca II H are blended in SDSS data and were not included in our sample). All of the line measurements were made by integrating over the specific line region (8 Å wide centered on the line) and subtracting off the mean flux calculated from two adjacent continuum regions. Equivalent widths (EW) were computed for each line by dividing the integrated line flux by the mean continuum value.

For all of the active stars in the sample (see West et al. 2010, for definition of activity) we computed the ratio of luminosity in the emission line as compared to the bolo-

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<sup>1</sup><http://vizier.u-strasbg.fr/cgi-bin/VizieR>

<sup>2</sup>The order of the co-authors was based on the number of spectra examined.

metric luminosity ( $L_{\text{line}}/L_{\text{bol}}$ ). We followed the methods of Hall (1996), Walkowicz et al. (2004) and West & Hawley (2008) who derived  $\chi$  factors for the Balmer and Ca II chromospheric lines as a function of M dwarf spectral type. The  $L_{\text{line}}/L_{\text{bol}}$  values were computed by multiplying the EW of each active star by the appropriate  $\chi$  value. Formal uncertainties were computed for each  $L_{\text{line}}/L_{\text{bol}}$  value and are included in the final database.

We also computed the metal sensitive parameter  $\zeta$ , defined by Lépine et al. (2007), which uses a combination of the TiO5, CaH2, and CaH3 molecular band indices to separate the sample into different metallicity classes. This is similar to the Gizis (1997) classification system but was re-calibrated using wide common proper motion pairs that were assumed to be at the same metallicity. Stars with solar metallicity ( $[\text{Fe}/\text{H}]=0$ ) have  $\zeta$  values  $\sim 1$  and stars with  $[\text{Fe}/\text{H}]=-1$  have  $\zeta \sim 0.4$  (Woolf et al. 2009). Although there is considerable scatter in the  $[\text{Fe}/\text{H}]$  versus  $\zeta$  relation at high-metallicities, this parameter is very useful for finding and classifying low-metallicity stars that are likely members of the Galactic halo.

As with previous SDSS spectroscopic catalogs of low-mass stars, we remind the community that these data do not represent a complete sample and that the complicated SDSS spectral targeting introduces a variety of selection effects. However, our new sample covers a large range of values for many of the physical attributes of the M dwarfs, including parameters that are sensitive to activity, metallicity, and Galactic motion, making accurate activity, kinematic, and chemical analyses possible. In addition, because some of the derived quantities are computed by automatic routines, values for a small percentage of individual stars may be incorrect; this should not affect large statistical results. Users are nevertheless cautioned to understand the origin of specific data products before using them indiscriminately.

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Figure 1.  $2'' \times 2''$  *gri* color composite images of more than 3000 M dwarfs from the SDSS DR7 M dwarf catalog. The images have been mosaicked to reproduce the Cool Stars 16 logo (original logo credit: L. Walkowicz).

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